Islands in the Stream 2002: Exploring Underwater Oases

NOAA Office of Ocean Exploration

Mission One: SUMMARY

Characterization of Deep Reef Habitat with Particular Emphasis on Discovery, Exploration and Description of Reef Fish Spawning Sites

July 27 – August 5, 2002

Bank sea bass, a common reef fish that spawns on deep shelf-edge reefs, caught during hook-and-line tagging of fish.

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ABSTRACT

Very little is known about the spawning locations and behavior of economically and ecologically valuable snappers, groupers, porgies and other reef fishes off the southeastern coast of the US. As populations of these fish continue to decline, and traditional methods to reverse this trend prove ineffective, some deep reefs are being considered for Marine Protected Area status. Of particular concern is protecting those spawning habitats and locations that are essential to completing the life cycle of these over-fished species. This expedition used historic information on capture locations of reef fish in spawning condition to direct submersible and shipboard sampling of spawning locations. The successful cruise included 13 submersible dives that resulted in 34 hours of annotated digital video of shelf reef habitat and fauna, including an invasive fish species. In addition, more than 25 hours of side scan sonar, supplemented by 25 hours of fathometer transects, produced some of the most highly resolved imaging of reef morphology and suspected reef fish spawning grounds. This new information will help maximize the effectiveness of management strategies as well as be conveyed to the South Atlantic Fishery Management Council to support the ongoing MPA designation process.

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KEY FINDINGS AND OUTCOMES

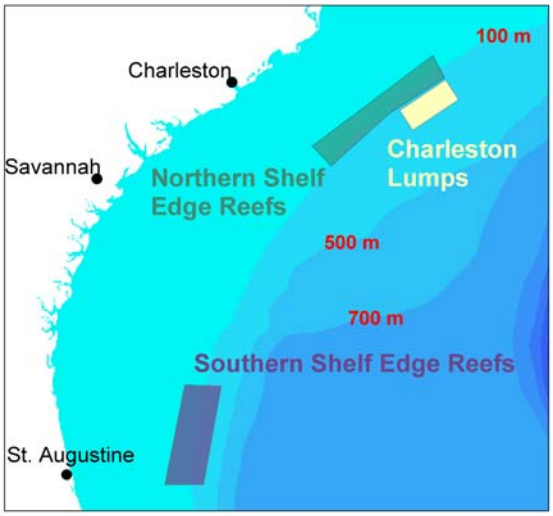
Findings

Approximately 34 hours of annotated digital video documented the deep reef habitats and biota studied from St. Augustine, FL to Charleston, SC. Observers noted a transition of communities from the southern shelf edge reefs (SSE) at St. Augustine and Jacksonville Scarps, FL to northern shelf edge reefs (NSE) at Julian's and Scamp Ridges, SC. Significantly different habitat and biota were noted along the upper slope reefs at Charleston Lumps, SC (CL).

Reef Morphology and Geology: SSE reefs were a continuous ridge of rock with a blocky pattern, generally 2-3 m in relief, but became more discontinuous features of rubble and bio-eroded rock at NSE sites. No distinct ridge or scarp features occurred at CL, which consisted of mounds over 100 ft high with large rock outcrops, small rubble and hard pavements. SSE and NSE sediments were lithogenic (eroded rock) and biogenic (from biological sources) with little-to-no fine grains. CL sediments contained more fine sediment and coarse fraction of sand, shell and rock fragments, and small rounded rock nodules.

Invertebrates: SSE sites contained a diverse community of invertebrates (large sponges, wire corals, bryozoa and crustaceans). There were decreasing populations of larger species at NSE sites, which were replaced by smaller tunicates, encrusting sponges and hydrozoans. CL was inhabited by tube worms, sponges and echinoderms (starfish and sea urchins).

Fish: The highest abundance and diversity was associated with the high relief at SSE reefs - dominated by blue angelfish, squirrelfish, yellowtail reef fish, reef butterflyfish, tomtate, wrasses and vermilion snapper. There was a decline in these species at the NSE sites, where knobbed porgy and spotfin butterflyfish were abundant. Low species diversity and abundance were observed at CL – yellowfin bass, blackbelly rosefish, blueline tilefish, and small snowy grouper were noted. Indications of spawning areas observed – scamp grouper in gray head color phase, pre-spawning aggregation of red snapper, courtship behavior in hogfish and possible nest guarding in gray triggerfish.



Study Areas: July 28-August 5

Non-Indigenous Species: Lionfish (*Pterois volitans*), a highly venomous species native to western Pacific waters, were noted at 3 of 9 shallow water dives along shelf edge reefs in SC.

Outcomes

Improved Reef Mapping: Side scan sonar and fathometer transects (more than 50 survey hours) greatly improved resolution of reef features and suspected reef fish spawning grounds.

Ocean Explorer Website: Near real-time postings – stories, pictures and video clips - from mission scientists and educators describing daily at-sea activities and discoveries. Thousands of unique users followed the expedition daily.

Education Benefits: During the mission - two teachers-at-sea; lesson plan development; sea-to-shore conference call with teachers as part of Professional Development Institute; field data collection for graduate student; guided student tours during "open house". Post mission – National Marine Educators Association presentations; SC Aquarium collaborations and exhibits; Oceanica web site support for higher education science activities.

Media Coverage: Several local newspaper stories and a supportive editorial in Charleston, SC and Ft. Pierce, FL. Digital video highlights tape (with annotation) distributed to regional and national markets.

MISSION RATIONALE AND OBJECTIVES

Results of this mission may be able to shed some light on the age-old statement that "the fishing just isn't as good as it used to be," especially for the snapper and grouper species along the South Atlantic shelf and upper slope. Previous statements that "the fishes have just moved temporarily over the next hill and will return" do not seem to be true as this mission targeted "all the right places" with consistent results -- few, if any, commercial species, such as gag grouper, scamp grouper, vermilion snapper and red porgy. The fishing industry is still landing these same species, so there are some remaining, but catches are much smaller than in previous years. Since some of the groupers may take 25-35 years to grow, years of fishing have removed these fishes faster than they can grow and reproduce. One strategy currently being debated is the designation of important spawning locations as marine protected areas that afford some level of protection during this critical life stage.

Measuring a vermilion snapper prior to tag and release.

An important data gap in the challenge to define these areas, preserve biodiversity, and support sustainable fisheries, is the discovery and characterization of the spawning habitats and the characterization of oceanographic processes that affect them. Scientists hypothesize that deep reef fishes at the shelf edge (50-250 m deep) spawn in locations that ensure that eggs and larvae are removed from reef predators by prevailing currents that also retain larvae in the vicinity of settlement habitats, where larvae settle out of the plankton and begin living on the bottom reefs. Since 1973, the MARMAP (Marine Resources Monitoring, Assessment and Prediction) program has monitored the distribution, abundance, growth and reproduction of reef fishes. Although much has been gained regarding trends in abundance of fishes and aspects of life history such as growth rates, size, age at maturity, and number of eggs spawned, still very little is known about spawning locations and behavior of economically valuable snapper, grouper, porgies and other reef fish in the South Atlantic. By discovering and mapping these features during this mission, it is hoped to discover some of those characteristics that define spawning grounds. The results will be contributed to the MARMAP database and will be used to support efforts by the South Atlantic Fishery Management Council (and many others) to identify appropriate marine protected areas. Specific mission objectives included:

- locate and map spawning grounds of deep reef fishes
- collect early life history stages to confirm spawning and detect transport patterns of larvae
- describe fish and invertebrate assemblages, benthic habitats, and oceanographic features of these deep reef habitats
- describe distribution of spawning fishes, their larvae and their habitats in relation to potential Marine Protected Areas

MISSION OPERATIONS AND SCHEDULE

This mission was staged from Harbor Branch Oceanographic Institution (HBOI) in Ft. Pierce, FL on July 27 aboard the *R/V Seward Johnson* (*SJ*) and with the submersible *Johnson-Sea-Link II*. Following a ship refueling stop in Ft. Pierce, the *SJ* transited to the St. Augustine Scarp, FL and was on site early on July 28, where a full suite of sub and science operations occurred. Mechanical problems with the SJ necessitated a return to Ft. Pierce on July 29. Following an overnight transit, the mission continued at Jacksonville Scarp, FL on July 30. Wind and high seas forced a cancellation of sub operations at Julian's Ridge, SC on July 31, but subsided enough to resume full operations at this site on August 1 and Scamp Ridge, SC on August 2. From August 3 - 5, sub and science activities occurred at the Charleston Lumps South and North sites as well as the Georgetown Hole, SC location. The mission ended at 12:00 on August 5 with an at-sea transfer of personnel and replacement by the science team for leg two along the NC shelf. In all, a total of 8 1/2 sea days supported 6 1/2 days of sub operations and 7 1/2 days of shipboard science activities.

Launching the *Johnson-Sea-Link II* submersible from the *R/V Seaward Johnson*.

Date	Location	SUB	Bathymetry		Plankton		Sediment	CTD	Fish Survey	
		JSL2 Dive	Fathometer	Side Scan	Bongo Net	Neuston Net	Young Grab	Salinity, Temperature, Density	Hook & Line	Dip Nets
27-Jul	Ft. Pierce, FL				-- transit --					
28-Jul	St. Augustine Scarp, FL	■	■	■			■			
29-Jul	FT. Pierce, FL				-- in port: maintenance --					
30-Jul	Jacksonville Scarp, FL	■	■				■	■		■
31-Jul	Julians Ridge, SC		■	■	■	■	■	■	■	■
1-Aug	Julians Ridge, SC	■	■	■	■	■	■	■		
2-Aug	Scamp Ridge, Sc	■	■	■	■	■	■	■	■	
3-Aug	Charleston Lumps South, SC	■	■	■			■			
4-Aug	Charleston Lumps North, SC	■	■	■	■	■				
	Georgetown Hole, SC	■	■	■					■	
5-Aug	Georgetown Hole, SC	■	■		■	■	■			

Submersible and shipboard activities conducted at each reef site.

SITE AND TARGET SELECTION

The mission explored shelf-edge and upper slope reefs off St. Augustine FL, Jacksonville FL and Charleston SC, ranging in depths from 45-200 m. Prior to the mission, the NMFS-SC DNR historical database of suspected or known locations of large reef fish aggregations and spawning activity was used to identify potential target sites. These areas are well-established commercial and recreational fishing sites that have experienced declines in top-level predators and, in turn, affected communities down to the benthic invertebrates. Many of these target sites also lie within boundaries of proposed marine protected areas. Thus, to maximize the value of the information gained from submersible dive time for scientific and management purposes, sites were selected that had the potential habitat to support spawning aggregations of commercially-important reef fish and that were simultaneously being considered for MPA status. During the mission, each target site was refined using side scan sonar and shipboard fathometer surveys to better define reef morphology and pinpoint vertical relief features. The target sites generally occurred along three shelf reef types:

Typical Sub Dive

- launch from ship
- once on bottom, transit to target location
- conduct standardized 4-minute transects, video documenting reef habitat, fishes and invertebrates (as many as 15 of these)
- collect 5 surficial sediment samples near the reef and 5 samples at 20-30 m from the reef
- collect invertebrates, fish, rock, and coral as appropriate for confirmation of species identification

- Shelf-edge reefs (50-70 m) had moderate relief (1-5 m) with outcrops and ridges along the first break in the continental shelf. Along the FL coast (St. Augustine Scarp and Jacksonville Scarp), the reef was more continuous and at depths of 50-60 m. The reef became more intermittent as it moved north towards Julian's Ridge and Scamp Ridge off SC and it occurred at depths of 45-60 m.

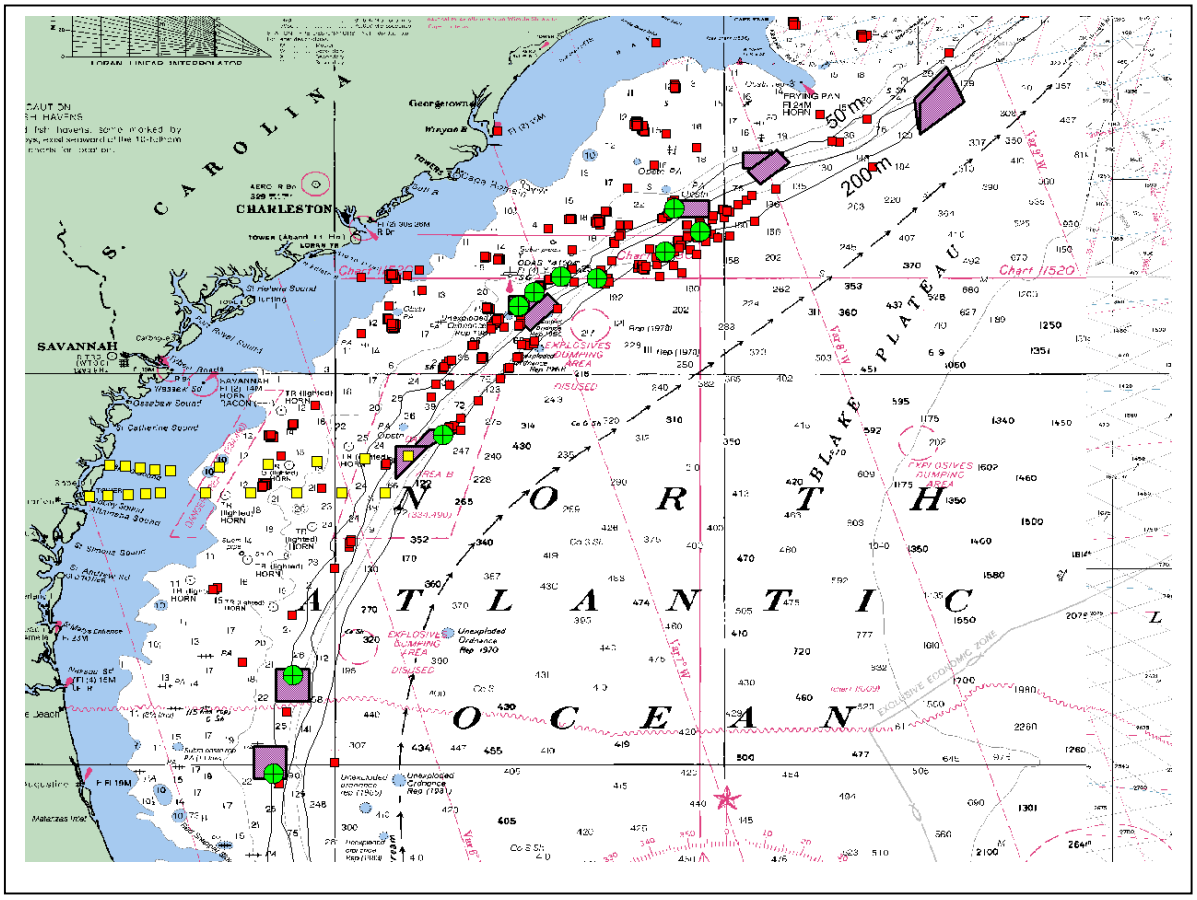
- Upper slope reefs (175-245 m) - The Charleston Lumps are two areas, 10 miles apart (North and South), on the upper continental slope. This was not a continuous reef like the shelf edge, but consisted of separate mounds or low pinnacles where the bottom

Typical Day

0000-0600	side scan sonar imaging of reef morphology
0600-0800	fathometer surveys of reef to identify sub dive locations
0900-1230	sub dive #1
1300-1600	sediment samples, plankton tows, CTD, hook & line, dip net surveys
1630-2000	sub dive #2
2000-0000	side scan sonar imaging of reef morphology, plankton tows, CTD, and sediment samples

rose from 230 m to 170 m, then continued down the continental slope.

- Smooth mud-clay bottom near upper slope reef, where tilefish constructed burrows and created habitat for a unique assemblage of benthic invertebrates and fishes



Target locations for at-sea operations are depicted by green circles. There are nine dive sites and one alternate site shown. The red squares indicate suspected fish spawning sites and purple polygons are MPA sites under consideration by the SAFMC. Yellow squares indicate benthic grab stations monitored by NOAA as part of studies to characterize Gray's Reef National Marine Sanctuary off the coast of Georgia.

INITIAL IMPRESSIONS

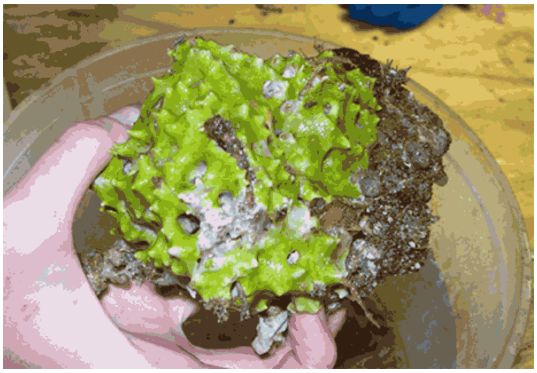
The following section provides a preliminary interpretation of mission results. It begins by describing the reef habitats in significant detail, as these are the suspected locations of reef fish habitat. Subsequently, observations of fish distribution and abundance as well as benthic invertebrates and the *Sargassum* community are described in relation to the varied reef characteristics from Florida to South Carolina.

DEFINING THE REEFS - GEOLOGY AND SEDIMENTS

In this region, the Gulf Stream moves swiftly northward along the shelf-edge and upper slope, and supplies the region with strong currents which have swept clean many surfaces of the hard rock, exposing them at the seafloor's surface. These rocky outcrop exposures are referred to as "hardground," and it is upon hardground that the underwater oases of organisms congregate. As the mission tracked northward, seven deep reef hardground sites were visited.

SHELF EDGE SITES

The five Florida and South Carolina shelf-edge sites showed a progressive northward change in the geologic structure and in the nature of the rocky outcrops. All of the shelf-edge hardground rocks collected were completely enveloped by a diverse community of invertebrate organisms (sponges, soft coral, bryozoa and crustaceans). The assemblage of organisms varied as the mission moved northward, with decreasing populations of resident amphipods, wire corals and barnacles, and increasing tube-building worms as examples.



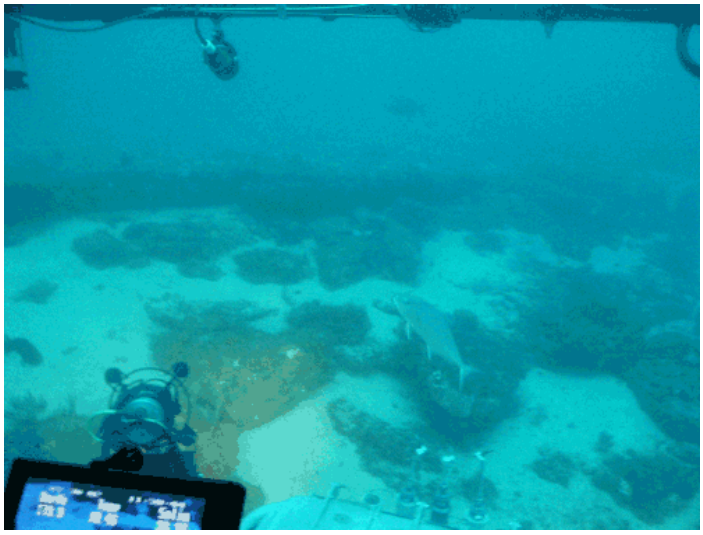
Green sponge attached to rock.

Sediments associated with these shelf-edge reefs were composed of lithogenic (from eroded rock) and biogenic (from biological sources such as mollusk shells) fine-to-coarse sands and biogenic rubble. Although not fully analyzed, the coarse fraction of these samples was nearly 100% shell, coral, and bryozoan fragments. The medium size fraction had abundant quartz and other mineral grains common on modern beaches. Sediments throughout the transect of these shelf-edge reefs appeared to have little to no fine grains, the result of swift Gulf Stream currents that prevent deposition clay and silt, while removing any fine sediments produced as a result of rock erosion.

The St. Augustine Scarp was a continuous ridge of rock with 2-3 m of relief. The rocks themselves were often 1 m in size and squared-off. In places they were almost perfectly aligned in a grid pattern, and one could imagine that they'd

been carefully arranged on the seafloor. The blocky nature, however, is likely the result of faulting. The rocks collected were completely covered with invertebrates. Although they could not be broken on board the ship to expose a fresh surface, it is anticipated that the reef hardground is a sandstone cemented with fine-grained calcium carbonate.

The Jacksonville Scarp was a discontinuous feature with lower relief of 1-2 m. It consisted more of large rock rubble in a narrow band of about 30 m width. The sands at the base of this reef were only a thin veneer blanketing a very hard underlying rock pavement. Similar to St. Augustine, many parallel and blocky fractures were observed. Sand ripples within sand-filled fractures indicated the occurrence of strong bottom currents in this area.



The Jacksonville Scarp, as seen from the *Johnson-Sea-Link II* submersible.

Julian's Ridge and Scamp Ridge consisted of severely bio-eroded rock, making the hardground irregular and rugged, with 2–4 m relief. The rocks of these ridges were pitted with many overhangs and small caverns that served as excellent fish habitat. The blocky pattern of faulting observed in the previous sites was no longer evident. Fresh, broken surfaces of these rocks were examined, revealing quartz-rich sandstone with a carbonate cement. One of the rock samples recovered was coated in a 0.5 cm sandy mucus – the likely product of bio-erosion in action.

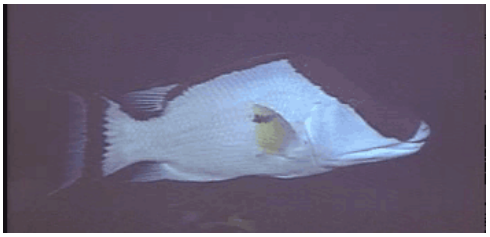
UPPER SLOPE SITES

The rocks and sediments of the Charleston Lumps (South and North) were entirely different from rocks collected at the shallow, shelf-edge sites. These upper slope rocks were denser and smoother, and were similar to manganese-phosphorite rocks previously recovered from nearby upper slope sites (i.e., the Charleston Bump area). Presumably, they were formed as the result of precipitation of manganese and phosphorus minerals from seawater during ancient periods of high productivity. Compared to shelf-edge rocks, far fewer invertebrates inhabited the upper slope hardground. One very large rock was partially buried in the surrounding sediment. A clear division of "live rock" and nearly barren rock was seen where the water/sediment interface occurred. Only a few large tube worms inhabited the rock's buried underside.

Sediments of the upper slope were a reflection of both the local eroded rocks and the resident biota. These samples contained more fine material than the shelf-edge sediments collected. The sand-sized fraction was composed primarily of abundant tiny (< 1 mm) manganese-phosphorite nodules and shell fragments. The coarse fraction was composed of larger (0.2 – 1.0 cm) nodules and rock fragments, along with shell material, rock-encrusted worm tubes, and sea urchin spines.

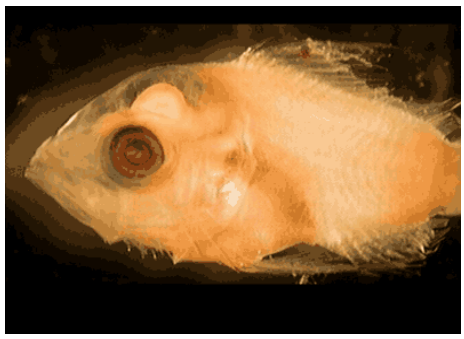
FISH

Reef habitat off St. Augustine, FL to Georgetown, SC was visited with the Johnson Sea Link II thirteen times. Ten of the dives were conducted on shelf edge reefs in water depths of approximately 55-60 m. This habitat consisted of exposed rocks and outcrops with relief of 1-10 m. Three dives took place on deeper reefs off Georgetown, SC that consisted of large mounds, with rock rubble and outcrops at water depths extending from 185-215 m.



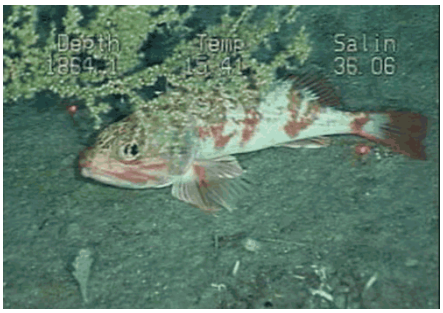
Adult male hogfish.

Small fishes such as blue angelfish, squirrelfish, yellowtail reef fish, purple reef fish, reef butterflyfish, bank butterflyfish, tomtate, small adult vermilion snapper, and wrasses dominated the fish community at the shelf edge sites in 55-60 m of water. Other species that occurred frequently but in lower abundances were spotfin hogfish and tattlers. As we moved from the shelf edge reefs off FL to those off SC, there was a noticeable decline in the number of bigeyes, squirrelfish, and vermilion snapper as well as an increase in the abundance of knobbed porgy and spotfin butterflyfish. As expected, abundance and diversity were noticeably higher at the reefs with highest relief. Notable observations related to fish reproduction were: 1) the presence at three dive sites of scamp grouper in the gray-head courtship color phase, 2) a potential pre-spawning aggregation composed of at least 200 red snapper, 3) a pair of hogfish apparently in courtship display, and 4) gray triggerfish possibly guarding nests consisting of hollowed-out depressions in the sand. Additional study of videotapes is needed to confirm spawning behavior.



Snapper larva

Some of these reefs were visited by the same scientists, using the same submersible, 17 years ago. One striking observation from the week's dives is the amount of very good rocky habitat in which species of commercial or recreational importance are rare or in some cases are lacking. During the 1980s, gag grouper, red porgy, and vermilion snapper were abundant on these reefs.



Blackbelly rosefish

During our dives, gag grouper and red porgy were absent and large vermilion snapper were rare.

Species abundance and diversity was much lower on the reefs at depths of 185-215 m than on the shallower shelf edge reefs. Species found in this habitat included yellowfin bass, blackbelly rosefish, blueline tilefish, and snowy grouper. This area was also visited with a submersible 17 years ago and there has been a noticeable decline in the size of snowy grouper.

INVERTEBRATES

The Gulf Stream has a significant impact on the invertebrate communities that are part of the deep water reef ecosystems, bringing both warmth and nutrients. As the mission traveled along the southeastern coast, a large diversity of invertebrate life was associated with the deep water reefs. In the southern locations, the St. Augustine Scarp and Jacksonville Scarp were closer to the main axis of the Gulf Stream, and the invertebrate communities were dominated by large, diverse specimens. There, massive sponges, fields of wire corals, and dense colonies of fan worms that form complex networks of tubes that resemble lace were observed.

A sponge collected from a shelf-edge reef, showing the numerous canals and cavities that are often occupied by symbiotic worms and crustaceans.

Worm tubes scraped from a rock collected at the shelf edge.

Farther north, off the coast of South Carolina, the invertebrate communities on rocky reefs were quite different. Here the Gulf Stream follows a more meandering course, resulting in more variable bottom temperatures. These areas were more subject to seasonal cooling and shifts in current regimes, but benefit from the influx of nutrients that are upwelled at the core of Gulf Stream eddies. Two of the reefs visited, Julian's Ridge and Scamp Ridge, were dominated by smaller invertebrates such as various colored tunicates, many varieties of encrusting sponges,

and delicate hydrozoans. The larger species of coral and sponge observed off Florida were also found, but were reduced in size and number. The Charleston Lumps were the deepest areas explored at 185-215 m and had finer sediments near the reefs than those sediments found at all the other locations. Numerous echinoderms (starfish and sea urchins) inhabited the Lumps, possibly drawn to the silty bottom around the rocky outcrops, which is a habitat conducive to burrowing and foraging for their infaunal prey items.

Sea Anemone.

NON-INDIGENOUS SPECIES

Perhaps the most sensational discovery of the mission was the sighting of an underwater invader to this region. The red lionfish, *Pterois volitans,* is an unmistakable marine fish with highly venomous spines is native to western Pacific waters. These fish have been recently reported from Florida to North Carolina, but have never been photo-documented or collected off South Carolina. Six lionfish were observed during three of the nine shallower dives made along the shelf-edge reefs off South Carolina. The frequent sighting of this invasive suggests that it is rapidly becoming established in these reef areas. Eradication of this species from these depths will be impossible, and the impacts of its presence is unknown at this time.

The red lionfish, with its highly venomous spines, was sighted several times during dive operations.

SEA SURFACE COMMUNITIES

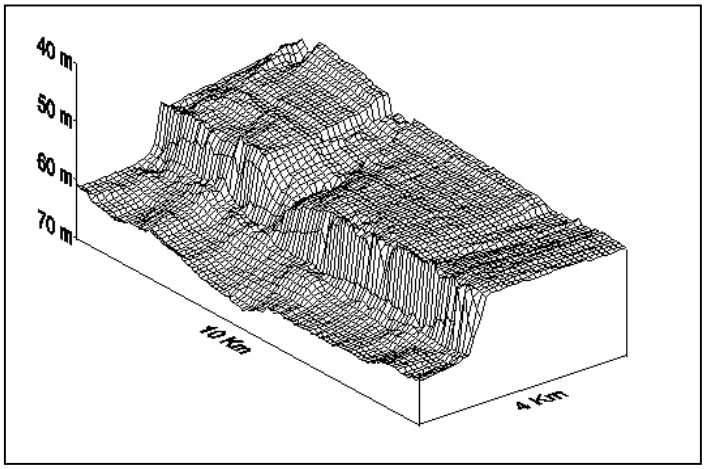
Although a large portion of the mission has been spent on the ocean floor examining fish and invertebrate communities, another vital ecosystem exists on the surface above these deep water oases. This community is based upon an organism commonly known by its genus *Sargassum*. Although resembling floating terrestrial plant matter, with "leaves" and buoyant "bulbs" and "stems", *Sargassum* is actually several species of free-floating brown algae. Because the ocean surface is basically void of suitable habitat for small fish and other organisms to shelter in, this floating cover is a refuge for a myriad of marine life. Many reef fishes have buoyant eggs and larvae that float to the surface to be distributed by the currents and tides. Before settling back to the reef environment, eggs and larvae of some fishes, such as wreckfish, filefish and triggerfish develop into juvenile fish that spend one to several months in this

nursery-like setting. The *Sargassum* can be considered a safe middle ground for these vulnerable stages of life.

Although sightings of *Sargassum* were at a minimum on this leg of the cruise, a few samples were collected using long-handled dipnets. The diversity of life was truly amazing. Hydroids attached to the various fronds seem to be close to the bottom of the *Sargassum* food chain, followed by nudibranchs, different species of shrimp and crabs, and finally juvenile fishes. By far the most common fishes encountered in this habitat were filefishes - almost every piece of *Sargassum*, no matter how small, had at least two or three filefish hiding in the protective cover. Numerous species of jacks and triggerfish were also observed and, in one instance, the heavily camouflaged sargassumfish (a species of frogfish) was captured. Although a much greater number of this unique organism was expected, the opportunity to observe this inter-related community in its natural habitat was an experience not to be missed.

MAPPING THE REEF SCARP AND THE "LUMPS"

Despite the importance of the reef, scarp and "lumps" as fisheries habitat, very little, if any, high quality mapping and imaging exists for the target sites visited during this mission. Data available to describe the morphology and features associated with the extent of St. Augustine Scarp, Jacksonville Scarp, Julian's Ridge, Scamp Ridge, Charleston Lumps and Georgetown Hole consisted of sets of points with no spatial connectivity. Acoustic imagery collected during this mission provided information on the surface geometry of these bathymetric features, such as areal coverage, bathymetric expression and spatial patterns. These images, coupled with "ground-truthing" data collected during the submersible dives and shipboard fathometer surveys, will facilitate the production of maps needed to better identify and describe important fish habitat.



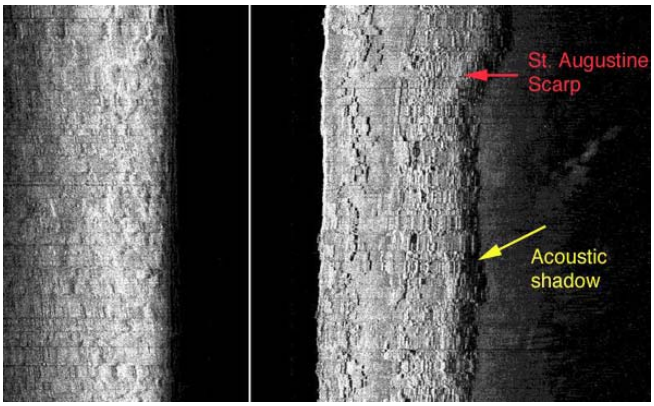
Depth contours from a fathometer survey of St. Augustine Scarp. The view is from offshore, looking southwestward at the face of the scarp.

The initial results of the side scan sonar imaging suggest the following concerning the reef structures from St. Augustine to Charleston Lumps:

ST. AUGUSTINE SCARP

The main ridge, evidenced by acoustic shadows and high side scan sonar backscatter, appeared to be a single elongated feature between 20 and 35 m wide with its long axis oriented NNE-SSW. Bathymetric relief caused by the

ridge, imaged as the side scan sonar tow vehicle intersected the ridge axis, appeared to be in the order of 10 m.



Raw side scan sonar record of the St. Augustine Scarp. The acoustic shadow outlines bottom-relief along the St. Augustine Scarp, which runs from top to bottom on the screen immediately left of the shadow.

JULIANS RIDGE

Unlike the St. Augustine Scarp, Julian's Ridge did not appear to correspond to a single, narrow elongated ridge, but rather as a series of isolated, broad, 'patches' of bottom relief of some 20 m in width. Although relief across the ridge was estimated to be as high as 6 m locally, it appeared to be on average ~1.5 m higher than the surrounding background bathymetry. Bottom features appeared to be oriented in a NE-SW direction. Occasional sand-wave fields were evident on the raw side scan sonar images, showing oriented waves of ~ 13 m in period (i.e. distance across).

SCAMP RIDGE

Side scan sonar images of Scamp Ridge showed a relatively homogeneous look throughout the entire area, and suggested the presence of only two end-member geomorphologic features: high-relief hard bottom and sand wave fields. A single ridge was identified on imagery in the Scamp Ridge area. On average, this ridge appeared to be ~70 m wide with a ~5m bathymetric expression, and oriented NE-SW. Adjacent to the main ridge, large fields of sand waves were identified on the sonar imagery. The period of these sand waves was estimated to be about 15 m, and extended for ~120 m in the longitudinal direction.

CHARLESTON LUMPS (NORTH AND SOUTH)

Imagery of the Charleston Lumps area, the deepest of all imaged sites, displayed a texture substantially different from all other areas visited during this mission. No evidence of a predominant ridge, scarp or rock outcrop was identified on the imagery. Instead the images suggest large fields of very patchy hard-bottom occasionally interrupted by isolated rock outcrops no more than 20 m in any dimension, and by small (< 50 m wide) fields of sandy bottom.

CONTRIBUTIONS TO THE MARINE PROTECTED AREA DESIGNATION PROCESS

The South Atlantic Fishery Management Council is currently undergoing a process to consider the use of Marine Protected Areas (MPAs) as a management tool for reef fishes. As part of the process, the Council has held a series of meetings of an MPA Advisory Committee made up of fishermen, conservationists, scientists, divers and others. In addition, the Council has held a series of public meetings and workshops, and will hold public hearings on specific proposed MPA sites in the future. An outcome of meetings held to date is that very little readily available scientific data can be used to help designate and locate MPAs. MPAs that include no-fishing zones are a drastic fishery management measure that may be necessary to stem the continuing decline in abundance and size of reef fish. Prior to taking such a serious management step, it is critical that data be gathered on the extent of important fish habitats, the abundance and diversity of fishes that occupy those habitats, and life history parameters for those fishes. In addition, it is extremely important to map habitats and fish distribution and abundance in potential MPAs, and to collect baseline data on which to measure any positive or negative effect of MPA designation. This mission has gathered essential data on location of fish habitats and estimates of abundance and diversity of economically valuable fishes and other reef fishes. It has also gathered data on the benthic communities that support the food chain that produces fishes, and the presence of invasive species (red lionfish) in potential MPAs and other deep reef locations. The data collected will be added to an existing database on life history of fishes that has been compiled by the investigators and presented to the Council. The additional data collected during this cruise will be a valuable source for siting MPAs and for evaluating their effects on reef fishes and associated communities.

MARINE EDUCATION

NOAA's Office of Ocean Exploration explicitly requires educational elements to be integrated within each mission, as well as to continue to develop educational materials that are derived from the science and discoveries of mission participants. During this mission, a primary education objective was to provide individual teachers with a first-hand knowledge of oceanographic research and a view of one of the unseen ecosystems of our region. On this leg, two South Carolina teachers were participants of the

Robin Salonich and Marty Ball, teachers at sea, helping out with sediment sampling.

scientific party: Marty Ball, a high school teacher from the Charleston County School District; and Robin Salonich, a middle school teacher from Lexington County School District. They were engaged in all of the scientific activities, including sediment and plankton sampling and processing, equipment deployments, annotations of dive video tapes, and daily log writing. Most importantly, both teachers were given the opportunity to experience the thrill of exploration first-hand by diving to the seafloor in the submersible *Johnson-Sea-Link II*. This level of shipboard and submersible engagement by teachers is of major significance because it is the classroom teacher who communicates daily the vibrancy, excitement and reality of scientific research to students – the new (not 'next'!) generation of young scientists.

An education component of this cruise that will continue to develop in subsequent months was the gathering of photos and video for use in the production of resource materials geared toward K-12 teachers and college students. Leslie Sautter and the staff of Project Oceanica (College of Charleston) are already developing numerous informative documentary format PowerPoint presentations related to topics such as the deployment/recovery of the *Johnson-Sea-Link II* submersible, sampling procedures (for fish counts, fish tagging, plankton, sediment, rock, and benthic ecology studies), and summaries of the various dives to the shelf-edge and upper slope reefs. These educational presentations will soon be available for downloading from the Project Oceanica web site (http://oceanica.cofc.edu). Oceanica will also work with members of the science party post-cruise to summarize some of the major findings. The Oceanica web site will continue to direct users to the Islands in the Stream 2002 site to continuously increase the visibility of ocean exploration.

Marine Education Outcomes

During Mission

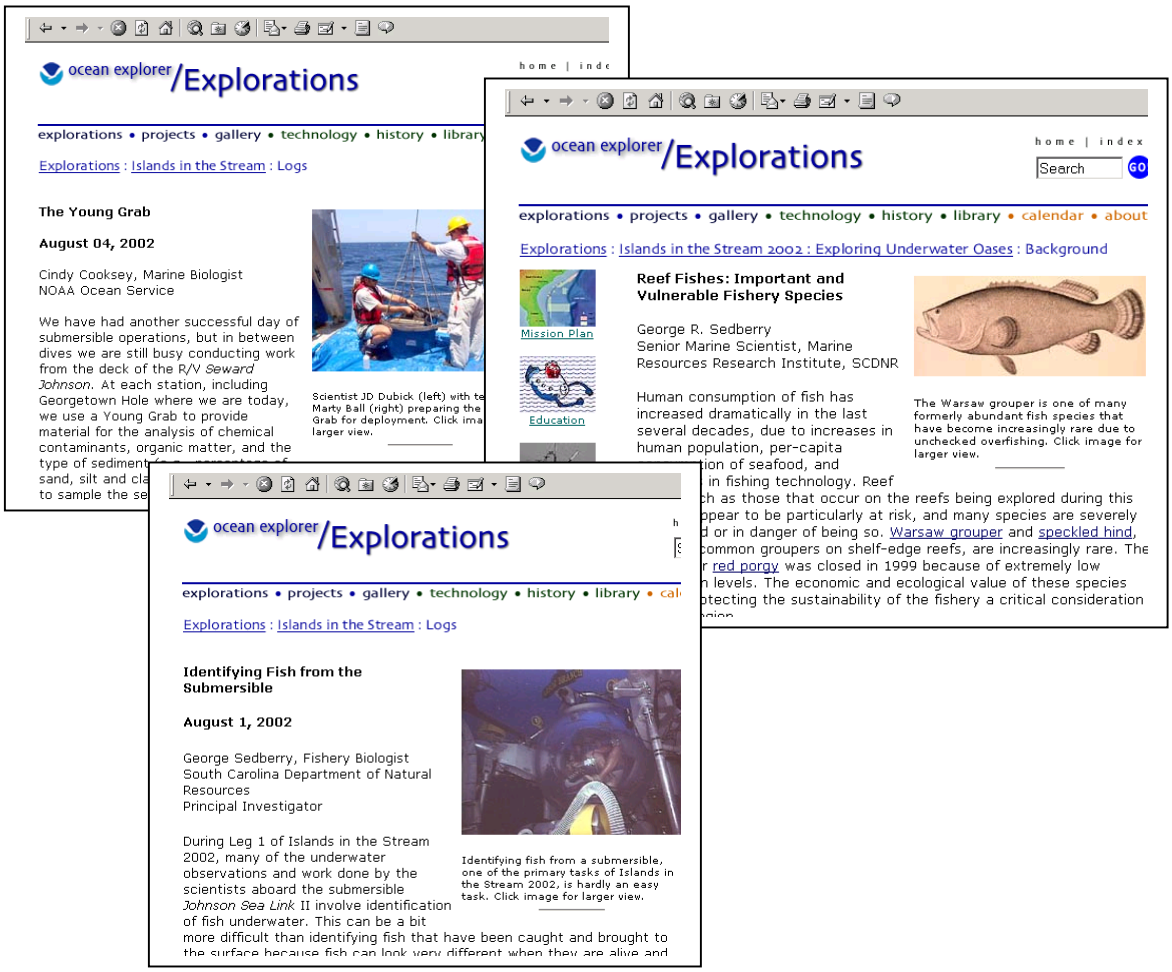
- Two Teachers-at-Sea participants
- One graduate student participant
- Lesson plans and hands-on classroom activities
- Shipboard experiments with lesson plans
- Contributions to NOAA's Ocean Explorer web site
- Education proposal collaborations among shipboard scientists
- Field data for one graduate student thesis

Post-Mission

- Public outreach via collaboration with SC Aquarium
- Downloadable presentations related to shipboard and science activities through Oceanica web site
- Professional development workshops for K-12 teachers based on scientific results
- Exhibit of cruise results at SC Aquarium
- Presentation of cruise results at National Marine Educators Association conference and state chapter meetings
- Presentation of results to civic and community education groups

NOAA's OCEAN EXPLORER WEB SITE

The web site http://oceanexplorer.noaa.gov continues to be one of NOAA's most popular web offerings. Drawing more than one million visitors a month, including thousands who follow expeditions on a daily basis, this medium provides an enormous opportunity to reach the public in near real-time. During this mission, scientists and educators contributed logs describing daily activities aboard the ship as well as exciting new discoveries (see Appendix 4). Adventures were brought to life through stories, pictures and video clips. Prior to the mission, two background pieces ("Reef Fishes" and "Spawning Grounds") were composed to help the reader understand the context for this cruise.



These pages from the Ocean Explorer website are samples of the daily logs and essays that included anecdotes, images, and videos.

MEDIA COVERAGE

Post-cruise products, such as annotated digital video highlights and annotated digital still images, were developed and distributed to regional and national markets. Several articles appeared in local newspapers in Charleston, SC.

The Post and Courier

[Fwd: Team ends 1st leg of ocean expedition.htm] - Netscape Message

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TODAY'S PAPER SPORTS BUSINESS ENTERTAINMENT ARCHIVES INDEX

News

Team ends 1st leg of ocean expedition

Second leg to probe hard, high ground of Continental Shelf

Tuesday, August 6, 2002

BY LYNNE LANGLEY
Of The Post and Courier Staff

The first leg of a national ocean adventure ended Monday in Shem Creek as a team of Charleston marine scientists came ashore after 10 days of deep-sea dives.

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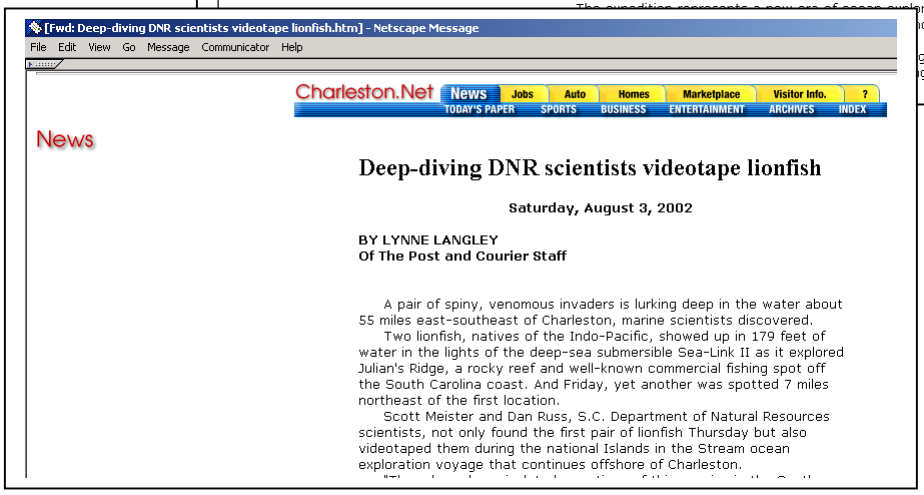

[Fwd: Deep-diving DNR scientists videotape lionfish.htm] - Netscape Message

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TODAY'S PAPER SPORTS BUSINESS ENTERTAINMENT ARCHIVES INDEX

News

Deep-diving DNR scientists videotape lionfish

Saturday, August 3, 2002

BY LYNNE LANGLEY
Of The Post and Courier Staff

A pair of spiny, venomous invaders is lurking deep in the water about 55 miles east-southeast of Charleston, marine scientists discovered.

Two lionfish, natives of the Indo-Pacific, showed up in 179 feet of water in the lights of the deep-sea submersible Sea-Link II as it explored Julian's Ridge, a rocky reef and well-known commercial fishing spot off the South Carolina coast. And Friday, yet another was spotted 7 miles northeast of the first location.

Scott Meister and Dan Russ, S.C. Department of Natural Resources scientists, not only found the first pair of lionfish Thursday but also videotaped them during the national Islands in the Stream ocean exploration voyage that continues offshore of Charleston.

Title	Author	Organization	City	Page	Date
Charleston scientist searches for secrets of the deep	Lynne Langley	The Post and Courier	Charleston, SC	1	07/26/02
Scientists get fish~s eye view of reef life	Lynne Langley	The Post and Courier	Charleston, SC	1	08/02/02
Deep-diving DNR scientists videotape lionfish	Lynne Langley	The Post and Courier	Charleston, SC	3	08/03/02
Team ends 1st leg of ocean expedition	Lynne Langley	The Post and Courier	Charleston, SC	1	08/06/02
Amazing ocean exploration	Editorial	The Post and Courier	Charleston, SC	14	08/09/02

Media coverage of this mission.

THOUGHTS FOR THE FUTURE

Much was learned during this mission. Several different types of reef formations were observed, mapped and evaluated, and video documentation was gathered of the kinds of fishes and invertebrates found associated with those different formations. A large number of videotaped transects were collected that will allow researchers to analyze fish abundance back in the lab. Most of the data were collected in areas that are being considered as MPAs, and along the edge of proposed MPAs. Previous experience of the investigators and others has shown an increase in abundance and size of fishes in MPAs, with spillover into adjacent areas where fishing is improved by catches of more and larger fish. The data collected during this mission, prior to any MPA designation, will allow for future evaluation of the effectiveness of MPAs in restoring fish stocks and in providing export of fishes to adjacent areas. Abundances of economically valuable groupers, snappers, porgies and tilefishes were generally low during submersible observations, and it is hoped that management efforts will result in higher fish counts in the future. We also need to determine if these protected areas will supply fish (via migration or dispersal of eggs and larvae in the currents) to sites that are far removed from the MPA, and additional future research is needed to track the movements of adult fish and eggs and larvae. This future work will add to the database collected during the OE 2002 mission, and will provide data needed to evaluate the effects of protective management to ensure sustained fisheries in the future. Future monitoring is needed to evaluate the successful invasion of red lionfish (documented during this mission) into the South Atlantic Bight.

Appendix 1:
Submersible Dive Summary

Starting location		Duration	Max Depth	Observers		Videos	Photos	No. Habitat	Samples Collected
lat	long	hours	feet	forward	aft	number	number	Transects	
29 56.3727	80 17.0710	3:03	198	Sedberry	Jutte	2	0	5	rock, sediment, sponge
29 59.5416	80 16.7192	3:24	201	Jutte	Cooksey	3	0	17	rock, sediment, sponge
30 24.027	80 12.932	2:42	195	Barans	Crowe	3	0	7	rock, sediment, sponge, coral, inverts
30 26.3338	80 12.2862	3:08	180	Sautter	Orlando	3	15	5	rock, sediment, sponge, coral
32 20.5432	79 02.7900	3:12	180	Dubick	Beal	3	30	16	rock, sediment, sponge
32 20.8468	79 02.1968	3:01	193	Meister	russ	3	6	14	rock, sediment
32 24.1267	78 59.9017	2:31	176	McGovern	Wyanski	3	0	15	rock, sediment, sponge
32 24.5753	78 59.3697	2:29	174	Loefer	Potter	2	0	11	rock, sediment
32 57.1459	78 19.1352	3:17	676	Sedberry	Solanich	3	50	13	rock,sediment, sponge, anemone
32 37.6506	78 19.4430	3:13	660	Ojeda	P-I-T	3	8	9	sediment
32 43.9375	78 06.7438	2:18	655	Loefer	Hollen	2	0	15	rock, sediment
32 51.0996	78 15.2664	3:02	178	Wyanski	Ball	3	0	16	sediment, coral, sponge
32 50.2352	78 15.90085	0:42	160	Cooksey	McGovern	1	0	0	none

Appendix 2:
Samples Collected by Submersible and Shipboard Activities

Date	Location	Collection	Sample Type	No. Samples	Sample Description
28-Jul	St. Augustine	Manipulator	Rock	3	Covered with benthic infauna
28-Jul	St. Augustine	Manipulator	Sponge	1	Sclerosponge
28-Jul	St. Augustine	Scoop	Sponge	2	Loggerhead Sponge
28-Jul	St. Augustine	Scoop	Sediment	21	Surficial sediments
28-Jul	St. Augustine	Young Grab	Sediment	1	Surficial sediments
30-Jul	Jacksonville	Manipulator	Rock	3	Covered with benthic infauna
30-Jul	Jacksonville	Scoop	Sponge	6	Sclerosponge
30-Jul	Jacksonville	Scoop	Coral	2	Gorgonian coral
30-Jul	Jacksonville	Scoop	Coral	1	Wire coral
30-Jul	Jacksonville	Scoop	Crab	1	Hermit crab
30-Jul	Jacksonville	Scoop	Sediment	10	Surficial sediments
30-Jul	Jacksonville	Young Grab	Sediment	1	Surficial Sediments
30-Jul	Jacksonville	Dip Net	Sargassum	many	Weed, fish, crabs, sea slug
31-Jul	Julians Ridge	Young Grab	Sediment		
31-Jul	Julians Ridge	Neuston Net	Plankton	2	Surface plankton, inverts
31-Jul	Julians Ridge	Bongo Net	Plankton	2	Surface plankton, inverts
31-Jul	Julians Ridge	Hook & Line	Fish	5	Shark (2), amberjack, tattler, bank bass
31-Jul	Julians Ridge	Dip Net	Sargassum	many	Weed, fish, crabs
1-Aug	Julians Ridge	Manipulator	Rock	2	Covered with benthic infauna
1-Aug	Julians Ridge	Scoop	Sponge	1	Sclerosponge
1-Aug	Julians Ridge	Scoop	Sediment	21	Surficial sediments
1-Aug	Julians Ridge	Neuston Net	Plankton	2	Surface plankton, inverts
1-Aug	Julians Ridge	Bongo Net	Plankton	2	Surface plankton, inverts
2-Aug	Scamp Ridge	Manipulator	Rock	2	Covered with benthic infauna
2-Aug	Scamp Ridge	Scoop	Sponge	1	Sclerosponge
2-Aug	Scamp Ridge	Scoop	Sediment	15	Surficial sediments
2-Aug	Scamp Ridge	Neuston Net	Plankton	1	Surface plankton, inverts
2-Aug	Scamp Ridge	Bongo Net	Plankton	1	Surface plankton, inverts
2-Aug	Scamp Ridge	Hook & Line	Fish	4	red snapper (2), vermilion snapper (2)
2-Aug	Scamp Ridge	Young Grab	Sediment	3	Surficial sediments
3-Aug	Charleston Lumps South	Manipulator	Rock	2	
3-Aug	Charleston Lumps South	Scoop	Sponge	2	Sclerosponge
3-Aug	Charleston Lumps South	Scoop	Sediment	21	Surficial sediments
3-Aug	Charleston Lumps South	Scoop	Invertebrate	1	anemone
3-Aug	Charleston Lumps South	Scoop	Coral	1	coral fragment
3-Aug	Charleston Lumps South	Young Grab	Sediment	5	Surficial sediments
4-Aug	Charleston Lumps North	Manipulator	Rock	2	
4-Aug	Charleston Lumps North	Scoop	Sediment	5	Surficial sediments
4-Aug	Charleston Lumps North	Neuston Net	Plankton	1	Surface plankton, inverts
4-Aug	Charleston Lumps North	Bongo Net	Plankton	1	Surface plankton, inverts
4-Aug	Georgetown Hole	Scoop	Sponge	1	
4-Aug	Georgetown Hole	Scoop	Sediment	5	Surficial sediments
4-Aug	Georgetown Hole	Scoop	Coral	1	soft coral
4-Aug	Georgetown Hole	Hook & Line	Fish	1	wahoo
5-Aug	Georgetown Hole	Young Grab	Sediment	6	Surficial sediments
5-Aug	Georgetown Hole	Neuston Net	Plankton	1	Surface plankton, inverts
5-Aug	Georgetown Hole	Bongo Net	Plankton	1	Surface plankton, inverts

Appendix 3:
Mission 1 Science Team

Name	**Affiliation**	**Role**
George Sedberry	SC DNR	Chief Scientist, Sub Ops
Paul Orlando	NOAA/NOS	Mission Coord, Sub Ops
Jeremy Potter	NOAA/OE	Web Coord, Sub Ops
Cindy Cooksey	NOAA/NOS/CEHBRC	Sub Ops, Benthic Sampling
Joshua Dubick	NOAA/NOS/CEHBRC	Sub Ops, Benthic Sampling
Pam Jutte	SC DNR	Sub Ops, Benthic Sampling
Stacie Crowe	SC DNR	Sub Ops, Benthic Sampling
Leslie Sautter	CofCharleston	Sub Ops, Geology, Education
Lisa Hollen	CofCharleston	Sub Ops, Geology, Education
Robin Salonich	Sandhills Intermed Schl	Sub Ops, Education
Marion Beal	SC DNR	Sub Ops, Plankton, Genetics
Jack McGovern	SC DNR	Sub Ops, Watch Chief
Charlie Barans	SC DNR	Sub Ops, Watch Chief, Sonar
David Wyanski	SC DNR	Sub Ops, Plankton
Marty Ball	Chas. Co. School District	Sub Ops, Education, Outreach
Scott Meister	SC DNR	Sub Ops, Plankton, Benthos
Dan Russ	SC DNR	Sub Ops, Plankton, Benthos
Josh Loefer	SC DNR	Sub Ops, Data Mgmt
German Ojeda	Coastal Carolina Univ	Sub Ops, Side Scan Sonar

Appendix 4:
Daily Logs and Background Pieces Written for the OceanExplorer Website

Date	Title	Author
July 27, 2002	Expedition Mobilization and Safety at Sea	Robin Salonich, Teacher Sandhills Intermediate School Jeremy Potter NOAA Office of Ocean Exploration
July 28, 2002	Sponge Commensals	Stacie Crowe, Marine Biologist SC Department of Natural Resources
July 29, 2002	Life on a Rock	Dr. Leslie Sautter Geology Department, College of Charleston Project Oceanica
July 30, 2002	Diverse Patterns of Reef Fish Reproduction	David M. Wyanski & John C. McGovern Marine Resources Research Institute SC Department of Natural Resources
July 31, 2002	Side Scan Sonar at the Edge	German Y. Ojeda Center for Marine and Wetland Studies, Coastal Carolina University Charlie Barans SC Department of Natural Resources Jeremy Potter NOAA Ocean Exploration
Aug 1, 2002	Identifying Fish from the Submersible	George Sedberry, Fishery Biologist SC Department of Natural Resources Principal Investigator
Aug 2, 2002	We're Being Invaded	Pam Jutte, Marine Scientist SC Department of Natural Resources Josh Loefer, Biologist SC Department of Natural Resources Scott Meister, Marine Biologist SC Department of Natural Resources
Aug 3, 2002	Sampling Techniques—Infaunal Organisms	Pam Jutte, Marine Scientist SC Department of Natural Resources
Aug 4, 2002	The Young Grab	Cindy Cooksey, Marine Biologist NOAA Ocean Service
Aug 5, 2002	Marine Protected Areas for Reef Fish	George Sedberry, Fishery Biologist SC Department of Natural Resources Principal Investigator
Background	Exploring Deep-reef Spawning Grounds	George Sedberry, Fishery Biologist SC Department of Natural Resources Principal Investigator
Background	Reef Fishes: Important and Vulnerable Fishery Species	George Sedberry, Fishery Biologist SC Department of Natural Resources Principal Investigator